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DEVELOPMENT OF A LOW LIGNIN HULL, HIGH ENERGY OAT AS A SUPERIOR RUMINANT FEED GRAIN FOR DOMESTIC AND EXPORT MARKETS

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Development of Low Lignin Hull, High Energy Oat as a Superior Ruminant Feed Grain for Domestic and Export Markets

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Abstract

This project was supported by the Saskatchewan Agriculture Development Fund, Super Oats Canada Ltd., the Crop Development Centre and the Prairie Feed Resources Centre, University of Saskatchewan. Objectives were the development of oat germplasm combining the low acid detergent lignin hull (LLH) and high oil groat (HOG) traits and proof of concept animal nutrition trials to validate the concept that this trait combination provides a valuable new ruminant feedstuff for Prairie oat growers and cattle feeders. The project was conducted as planned, although the severely inclement weather of the 2002 growing season limited progress. Inheritance studies indicate the LLH trait is simply inherited and that the LLH and HOG traits can be combined. Early stage LLH-HOG germplasm development has been conducted with > 20 LLH x HOG crosses processed through breeding program stages from F1 to F6 and with most advanced selections in 2002 Saskatoon yield trials. Field scale increases of the first LLH-HOG materials were grown in 2002. While successful, yields and grain quality were lower than expected due to drought. Proof of concept animal trials have been undertaken. A 2001 dairy cow feeding trial was completed using a simulated LLH-HOG ration (LLH hulls from one genotype recombined with HOG from another). Results were encouraging in that the diet formulated with simulated LLH-HOG oat was equal to the barley control diet, however the comparable standard oat diet was also similar. Treatments were confounded and compromised by diet pelleting necessitated by recombining of hulls and groats. 2001 LLH hull digestibility trials using steers and a second dairy production trial in 2002 demonstrated the improved rumen digestibility of the LLH material and its equivalence to barley. Linear program models indicated that the LLH-HOG oat had high relative value versus corn for beef grower and dairy diets in Canada and Korea. Results to date have been sufficiently positive to lead to Super Oats Canada Ltd. committing to continued support of the project for the four years 01-08-02 to 31-07-06.

Executive Summary

This project is supported by the Saskatchewan Agriculture Development Fund, Super Oats Canada Ltd.; the Crop Development Centre and the Prairie Feed Resources Centre, University of Saskatchewan.

The objectives were to further evaluate the feeding value of (low lignin hull) LLH oat and (HOG) high groat fat/oil oat, and, using accelerated plant breeding techniques, to combine these characteristics to develop a superior feed grain oat characterized by a low lignin/highly digestible hull, > 8% groat fat, high groat yield (80%) and premium agronomic performance for Saskatchewan producers.

CDC portion of project: The CDC undertook two basic aspects: (1) production and procurement of oat hull and grain samples for PFRC proof of concept trials and (2) development and evaluation of oat combining the LLH trait with high fat (HOG) and high groat yield.

Under (1) in 2000 the CDC provided the PFRC with supplies of LLH AC Assiniboia and HOG SA96121 for which the hulls and groats had been separated for recombination of a simulated LLH-HOG oat for the dairy feeding trial conducted during 2001. These samples also supplied the LLH and regular hulls for the 2001 hull digestibility trial using steers. In 2002 the CDC obtained sufficient supplies of a relatively high fat LLH AC Assiniboia sample and a relatively low fat normal hull lignin Derby sample for the 2002 dairy feeding trial.

Under (2), results from Mr. Shane Williams' MSc project indicated the LLH trait is simply inherited, and the germplasm development program indicated that LLH can be readily combined with HOG. Accelerated germplasm development procedures were utilized such that F3 derived F5 LLH-HOG genotypes were increased in New Zealand during the 2001/02 winter. Seed from these increases was used to plant various larger increases during 2002. Due to the severe spring drought at Saskatoon three major increases (1 –2 acres) were contracted out to Select Seed Growers at Saltcoats and Medstead, SK. Unfortunately the drought was nearly as bad at Medstead resulting in less than one-half the expected production and, while not as severe, poor conditions also hampered the Saltcoats increases resulting in less production than expected. Remaining increases grown at Saskatoon were severely affected by drought and inclement harvest conditions, but seed was produced for potential increase in 2003. Lack of increase success meant that 2002/03 feeding trials will not be possible due to grain shortages and poor physical grain quality. However, the increases provided seed stocks for larger scale production during 2003 and 2004 for more extensive feedlot trials. 2002 production problems have caused this portion of the overall project to be delayed by one year. In terms of most advanced breeding materials for variety development, selected RILs from the accelerated SSD sub-project were planted in 2002 Saskatoon Preliminary Yield trials where limited irrigation was available. % fat in these selections ranged from 8% to > 12% (normal checks 6%), with several lines with good groat yield and physical grain quality. While yield levels indicate improvement is required, it is very encouraging that several RILs yielded the same as the higher yield parent AC Assiniboia. More than twenty LLH x HOG cross combinations have been and are being processed at stages from F1 to F6 with appropriate populations under increase in the 2002/03 New Zealand winter nursery or in the CDC annual SSD program in the phytotron and greenhouses at Saskatoon.

PFRC portion of project: This portion of the project had as its objectives: a) to determine the extent and amount a LLH-HOG oat grain improves feeding value vs regular oat, b) to determine the nutrient behavior and animal response to LLH-HOG in typical diets, and c) to predict the potential competitiveness of LLH-HOG in the feed marketplace.

In the absence of an existing LLH-HOG oat, samples of LLH and HOG were used to simulate LLH-HOG oat grain. This simulation proved more difficult than expected as processing effects at the rumen fermentation level influenced animal response. These effects confounded a nimal response, however, good acceptability and capability to maintain high levels of milk production was shown.

Steer digestibility feeding trials with normal and LLH were used to evaluate the differences and real expected increase in energy with a low lignin hulled grain. The results clearly show that a low lignin hull has increased fibre digestibility and thus energy as compared to regular oat hulls.

A dairy feeding trial compared AC Assiniboia (LLH) and Derby (normal) oat with each other and barley. Statistical analysis is not complete, but the milk yield difference of 2.8 kg between AC Assiniboia and Derby is expected to be significant and AC Assiniboia appears to be equal to the two barley varieties.

To establish production sustainability, cost of production scenarios of oat in different soil zones were compared to other grains. Oat, in the black soil zone on conventional tilled stubble, has a much lower breakeven cost per tonne than barley ($113.82 vs. $122.74). Thus, if LLH-HOG oat has greater nutrient density, its competitiveness and sustainability are high.

The dairy production trials and steer digestibilities clearly show increased energy content with a LLH oat. These trials also demonstrated a unique role in diets from the fibre content not readily available from other feed sources. This provides increased value vs barley and corn. Production economics shows good competitiveness and sustainability for Western Canada. The further development of this oat grain variety based on demonstrated potential should be of high priority.

Technical Report

For simplicity in reporting the Crop Development Centre (CDC) and the Prairie Feed Resources Centre (PFRC) portions of the project are reported separately in this section.

Note re abbreviations: LLH = Low Acid Detergent Lignin Hull; HOG = High Oil (Fat) Groat; CDC = Crop Development Centre; PFRC = Prairie Feed Resources Centre; NZ = New Zealand; SSD = Single Seed Descent; RIL = Recombinant Inbred Line.

CDC portion of project:

CDC Responsibility #1: ***Production and procurement of oat hull and grain samples for PFRC proof of concept trials***

During 2000 the CDC provided the FRC with enough seed of the CDC HOG breeding line SA96121 and the LLH variety AC Assiniboia to produce sufficient acreage of each to provide grain supplies for the PFRC 2000/2001 feed evaluation portions of the project. The CDC arranged for post-harvest processing and transportation of the oat samples and provided the FRC with quantities of LLH, HOG, regular groats and regular hulls. Whole oats were transported to Northern Oats, Duck Lake, SK where samples were dehulled, groats and hulls separated and retained. On return to the PFRC these materials were recombined to produce various diet combinations including a LLH+HOG diet for a dairy nutritional trial. Extra LLH and normal hulls were used for the 2001 steer digestibility trial.

Early in 2002 the CDC identified a relatively high fat sample of AC Assiniboia (LLH) and a relatively low fat normal lignin hull sample of Derby in the Pedigree Seed production system. Several samples of each variety were obtained from MB and SK Seed Growers. Following fat analysis, 1 tonne of LLH AC Assiniboia with relatively high fat and 1 tonne of normal hull lignin Derby with relatively low fat were purchased and provided to the PFRC for a dairy production trial using rolled whole oat without the confounding of the hull/groat recombination which occurred during the 2001 dairy production trial. While this comparison was not equivalent to the eventual LLH-HOG oat vs normal oat, since the high vs low fat difference was not as great, it did give a valid comparison between LLH and normal hull quality and a good indication of the added value of higher groat fat.

CDC Responsibility #2: ***Development and evaluation of oat combining LLH with HOG and high groat yield***

1: Inheritance of LLH (Mr. Shane Williams MSc project): This project proceeded on schedule with 1,053 genotypes from 11 different crosses involving AC Assiniboia or its LLH relative Rbt 48 grown at Saskatoon in replicated hill plots during the summer of 2000. A significant portion of these materials were kindly provided to us by our collaborators at AAFC Ottawa and Lacombe. In addition, 103 lines from OT775 x AC Assiniboia, 53 lines from Elvy x AC Assiniboia and its reciprocal, and 156 lines from CDC Pacer x Rbt48 were grown over the 2000/01 winter in New Zealand to provide additional locations/replication for analysis and evaluation of LLH. During 2001 3,358 hills from four crosses were grown at Saskatoon as described below. Lignin analysis has been partially completed on materials produced in Saskatoon in 2000, in NZ over the 00/01winter and during the 2001 summer.

Populations evaluated as part of Shane Williams' MSc project

Pedigree	# genotypes Stoon 2000	# genotypes NZ 2000/01	# genotypes Stoon 2001	Source
CDC Pacer x Rbt48	351	156	172	CDC
Rbt48 x SO95265	59	0	0	CDC
OT546 x Rbt48	173	0	0	CDC
OT775 x AC Assiniboia	105	103	103	AAFC Lacombe
Elvy x AC Assiniboia	24	24	58	AAFC Lacombe
AC Assiniboia x Elvy	29	29	29	AAFC Lacombe
AC Assiniboia x Gem	69	0	0	AAFC Ottawa
AC Assiniboia x AC Francis	33	0	0	AAFC Ottawa
AC Assiniboia x AC Goslin	22	0	0	AAFC Ottawa
AC Assiniboia x OA970-10	13	0	0	AAFC Ottawa
AC Assiniboia x MAS4M112	175	0	175	AAFC Ottawa

Data to date indicates that the populations are segregating for low lignin vs. normal lignin hulls as expected. As anticipated, based on limited earlier evidence, the LLH trait is apparently relatively simply inherited. Results indicate no strong relationship between the LLH and HOG traits or other important grain quality factors meaning these traits can be readily combined.

During the course of Mr. Williams' project it has become evident that the process of lignin determination using the ANKOM fibre analysis system is considerably more labour and time consuming than anticipated. As a result the total number of lines and samples evaluated was reduced, but we are confident this will not affect the conclusions regarding the inheritance of the LLH trait.

A number of LLH and HLH (normal) lines have been identified from the OT775 x AC Assiniboia population. These have been provided to G. Scoles' plant molecular biology laboratory, where BSA (bulked segregant analysis) has been initiated to attempt to identify molecular markers associated with the LLH trait. Once identified we will be able to use MMAS (molecular marker assisted selection) to improve the efficiency of breeding for the LLH trait. That will significantly reduce resources necessary to screen for LLH and allow selection in earlier generations of the breeding program.

2. Development of genotypes combining LLH with HOG and high % groat:

a) LLH-HOG crosses made:

Summer 2002 crossing block:

02 Cross #	Pedigree	Comments	# of X'd seed
0219	SO01047 x 01-499-03-265	10% Groat Fat x LLH-HOG	1
0221	01-499-04-227 x OT2012	LLH-HOG x yld, ss, plp, < MY	6
0222	01-499-04-227 x OT394	LLH-HOG x Yld, Pc68, smut?, E, plp, MY, vl TW	2
0223	01-499-03-265 x OT2012	LLH-HOG x yld, ss, plp, < MY	3

F1 to be grown in 2003 Saskatoon spring greenhouse.
F2 to be grown at Saskatoon 2003.

Summer 2001 crossing block:

2001 Cross #	Pedigree	Comments	# of crossed seed
0101	SA00406 x OT2009	>>HOG, SlowR, wk, Ggr, MY, <Plp x LLH, ss, SRR, smut, Pc68, MY+, VGgr, L	33(17R)
0102	SA00406 x SA00657	>>HOG, SlowR, wk, Ggr, MY, <Plp x LLH, Yld, <TW, MY+, smut, Pc48	26(16R)
0103	SA00489 x OT2009	>HOG, MY+, CRR, VGgr x LLH, ss, SRR, smut, Pc68, MY+, VGgr. Late	27(23R)
0104	SA00489 x SA00657	>HOG, MY+, CRR, VGgr x LLH, Yld, <TW, MY+, smut, Pc48	6R
0105	SA00523 x OT2009	>HOG, Yld, VGgr, MY, %N, CRR, smut` x LLH, ss, SRR, smut, Pc68, MY+, VGgr., L	19R
0106	SA00523 x SA00657	>HOG, Yld, VGgr, MY, %N, CRR, smut` x LLH, Yld, <TW, MY+, smut, Pc48	22 (9R)
0107	OT395 x OT2009	Pc48, >HOG, smut, need plp x LLH, ss, SRR, smut, Pc68, MY+, VGgr. Late	13R

F1 grown in 2001/02 NZ winter nursery or in Saskatoon greenhouses.
F2 grown at Saskatoon in 2002.
F3 bulks in 2002/03 NZ winter nursery.
F4 space plants to be grown at Saskatoon 2003.
Crosses 0101, 0102 and 0103 are being processed through the F3 and F4 SSD in 2002/03 phytotron and greenhouses with F5 hills to be grown at Saskatoon in 2003.

Winter 2001 crossing block:

LLH-HOG 3 way crosses:	Comments	# 02/03 NZ F5 hills
(AC Assiniboia x OT386 F1) X SA96121*	(LLH x CRR, yld+) X HOG, %N	105
(AC Assiniboia x Wpg96Prel17 F1) X CDC Dancer	(LLH x HOG) X smut, MY	NA
(AC Assiniboia x OT386 F1) X IA9108-24	(LLH x CRR, yld+) X HOG	NA
(IA91098-2 x CDC Dancer F1) X AC Assiniboia*	(HOG x MY) X LLH	169
(SA97404 x SA97496 F1) X AC Assiniboia*	(HOG fat x high fat) X LLH	124

F1 grown at Saskatoon summer 2001.
F2 grown in 2001/02 NZ winter nursery.
F3 bulks grown at Saskatoon in 2002.
F4 bulks being grown in 2002/2003 NZ winter nursery.
F5 space planted bulk to be grown at Saskatoon 2003.

Three crosses marked * advanced via single seed descent (SSD) through the F2 and F3 generations in Saskatoon greenhouses during the 01/02 winter with F4 SSD generation grown at Saskatoon during 2002 with F5 RIL hills being grown in NZ 02/03 winter nursery.
F6 RIL yield plots to be grown at Saskatoon 2003.

Summer 2000 crossing block:

LLH crosses:	Comments	# of 02 F5 RIL hills
AC Assiniboia x SA96121	LLH x high fat, %N	0
AC Assiniboia x OT386	LLH x CRR, yld+, ss	0
AC Assiniboia x IA91098-2-4*	LLH x very high fat	212

F1 grown in 2000/01 NZ winter nursery.
F2 populations grown in Saskatoon during summer 2001.
F3 bulks grown in the 01/02 NZ winter nursery.
F4 space planted bulks grown at Saskatoon 2002.
F5 hills to be grown at Saskatoon 2003.
The cross marked * above was advanced through the F3 and F4 generations via SSD in greenhouses at Saskatoon during the 01/02 winter with resulting F5 SSD hills grown at Saskatoon during 2002.
F6 RIL yield plots to be grown at Saskatoon 2003.

Winter 2000 crossing block:

LLH crosses:	Comments
AC Assiniboia x SA96121*	Pc68, LLH x high fat
Wpg 96 Prel 17 x AC Assiniboia	Pc68, LLH x high fat
AC Assiniboia x LAC 505-001*	Pc68, LLH x high fat
96Mn22309 x AC Assiniboia*	Pc68, LLH x high fat
SA98110(OT397) x AC Assiniboia	Pc68, LLH x high fat
Triple Crown x AC Assiniboia	Pc68, LLH x HLH

F1 grown at Saskatoon during summer 2000.
F2 bulks grown in 2000/01 NZ winter nursery.
F3 bulks grown at Saskatoon during summer 2000.
F4 bulks grown in 01/02 NZ winter nursery.
F5 space planted bulks grown at Saskatoon in 2002.
F6 hills to be grown at Saskatoon 2003.

F2 and F3 SSD (Single Seed Descent) generations of three crosses marked * above were grown in the 2000/2001 winter SSD program in the Phytotron/greenhouse at Saskatoon. During the summer of 2001 field planted populations of F4 SSD lines from each cross were grown under irrigation (AC Ass x SA96121 - 204 lines; Wpg 96 Prel 17 x AC Ass - 222 lines; AS Ass x LAC 505-001 - 234 lines; 96Mn22309 x AC Ass - 242 lines). Resulting single plants gave enough seed to test for groat fat in Sept, 2001. That data was used to select F4 derived HOG lines (100 each from crosses AC Assiniboia x SA96121, AC Assiniboia x LAC505-001 and 96Mn22309 x AC Assiniboia) which were grown in the 01/02 NZ winter nursery as 2m F5 rows. These lines were segregating for the LLH trait. The spring 2002 harvested F5 NZ rows were tested for fat on their return from NZ with F6 LLH-HOG selections grown in Prelim YT's in 2002. Data

collected from these yield trials is described in the attached tables titled 2002 – LLH-HOGSSDYT1 through 7. All 71 putative LLH-HOG entries from 2002 LLH-HOGSSDYT#'s 1 – 4 have been sent to the 2002/03 NZ winter nursery for seed increase. This will allow those LLH-HOG lines eventually selected following complete quality analysis to be evaluated at multiple sites during 2003 and for seed to be increased for feed testing purposes. Pending LLH determination selected LLH-HOG lines from these 2002 YT's could be advanced to Coop trials by 2004 with potential variety release in the spring of 2006

In parallel F3 derived F4 multi-hill (2 hills per line) plot trials were grown under irrigation at Saskatoon for each of the four SSD populations. These provided enough seed for both fat and lignin analysis in Sept., 2001. This enabled identification of 16 F3 derived F5 LLH-HOG lines from three crosses for increase in NZ. By spreading the available seed thinly these were grown in three to five 5 square meter plots in the 01/02 NZ winter nursery. Unfortunately the 01/02 NZ season was poor with late planting and cold, wet stormy conditions leading to lodging and much less than average production. While 10 - 30 kg of seed per genotype were expected for return to Saskatoon in spring 2002 only 5 - 10 kg were returned. To enable larger area increases seed from F4 derived sister lines with LLH and similar % fat were combined for planting 2002 increases. Due to the severe spring drought at Saskatoon, and to spread the production risk , three larger scale increases were contracted out to Select Seed Growers at Medstead and Saltcoats, SK. The severe drought at Saskatoon proved this decision wise. Unfortunately the widespread 2002 drought and poor harvest conditions still negatively affected the increases, especially at Medstead where production was < 50% of normal. Production was as follows:

Identification	2002 % Fat	2002 Acres	2002 Increase Location	2002 Clean Seed	2003 Possible
AC Ass (LLH) x SA96121 (HOG)					
CDC-01-499-01 (75+95+103)	7.5	2.0	Medstead	685 kg	30 acres
AC Ass (LLH) x LAC505-001 (HOG)					
CDC-01-499-03 (103+135)	9.5	1.0	Saltcoats	254 kg	10 acres
CDC-01-499-03-265	10.4	0.25	KCRF	75 kg	4 acres
CDC-01-499-03-257	9.5	0.25	KCRF	50 kg	3 acres
CDC-01-499-03-309	8.9	0.25	KCRF	73 kg	4 acres
96Mn22309 (HOG) x AC Ass (LLH)					
CDC-01-499-04 (227+285)	8.2	2.0	Saltcoats	1000 kg	50 acres
CDC-01-499-04-157	8.2	0.6	KCRF	387 kg	20 acres
CDC-01-499-04-77	8.1	0.5	KCRF	220 kg	10 acres
HOG					
SA96121	8.2	1.0	KCRF	200	10 acres
OT387	7.5	1.0	KCRF	787	40 acres

Unfortunately poor growing conditions meant additional cost in that all seed produced had to be processed/cleaned to remove excessive portions of small, thin and immature seed. In addition, limited 2002 production and poor physical grain quality meant 2002/03 feeding trials could not be conducted. Fortunately, sufficient quantities of "seed" for field scale production of LLH-HOG oat in 2003 were produced. However, the lower than expected 2002 production means that feedlot scale testing planned for 2003/04 will be delayed until 2004/05. It should be noted that the probability of one of these F3 derived selections being released as a "variety" is not high

since the material, while LLH-HOG, is variable for other important traits. However, this process has allowed the production of LLH-HOG whole grain which can be processed in a normal fashion (rolled) to allow for final proof of concept feeding evaluation without the confounding effect of recombining LLH with HOG from different genotypes.

0.05 acre Bulk Increases of each of the 12 F3 derived LLH-HOG lines from these three crosses were also grown at KCRF during 2002. Normally these increases would provide another 50+ kg of seed, but due to the drought < 25 kg per genotype were harvested.

Note: In addition to these specific LLH-HOG crosses a number of other crosses have been made between LLH parents and other genotypes. Some of these "other" parents are foreign selections which have not been evaluated for % fat and once that is completed it may be that the CDC project has further LLH-HOG materials for evaluation.

b) Progress re HOG related to SuperOat Project:

In addition to our LLH-HOG work we continued development of very high groat fat normal hulled materials for possible use in the weaner pig feed market where very high energy density feed is required. As a result of these efforts and by using SSD and NZ winter nurseries to speed the process we had a number of lines with 9 - 11% groat fat in Preliminary Yield Trials at Saskatoon in 2001 and 2002. These lines have and will be utilized in our next series of LLH-HOG crosses to attempt to further boost the energy levels of the LLH-HOG project derivatives and to also provide LLH-HOG derivatives with a potential alternative high fat groat market with a more marketable hull by-product.

PFRC portion of project:

Evaluation and Feeding Studies with Low Lignin-High Oil Oat Grain

Objectives:

This portion of the LLH-HOG project had as its objectives:

a) To determine the extent and amount a low lignin hulled high oil oat grain will improve its feeding value compared to a regular oat:

b) Determine the nutrient behavior and animal response to a LL-HO oat grain in typical diets.

c) Predict the potential competitiveness a LL-HO oat variety would have in our feed market place. These objectives were to serve the basis of a decision making process whether such an oat variety can meet its predicted potential and should be developed.

In previous work, varieties of oat grain were identified that had a low lignin hull (LLH) and others which had a high oil groat (HOG). Through chemical analysis and *in vitro* and *in vivo* nutrient behavioral studies the potential feeding value of a LLH-HOG oat was predicted in simulated computer modeling. To provide proof of concept, digestibility feeding and production trials were initiated. In the absence of an oat variety with both key critical traits, separate samples of low lignin hulls and higher oil oat groats were used to simulate a test LLH-HOG oat

grain. Separate oat parts were also included in feeding trials to provide proof of concept by an indirect approach.

The simulation of a LLH-HOG oat grain proved to be more difficult than expected as processing effects at the rumen fermentation level influenced animal response. Appendix 1 summarizes a dairy production trial of a simulated LLH-HOG oat grain created by combining low lignin hulls with high oil oat groats. Unforeseen processing effects confounded animal response, however, good acceptability and capability to maintain high levels of milk production was shown. It also demonstrated the unique and different behavior a low lignin oat hull could have, if processed by rolling to retain particle size.

Steer digestibility feeding trials with high (normal) and low lignin hulls were used to evaluate the differences and real expected increase in energy with a low lignin hulled grain. The steer digestibility and feeding trial information is given in Appendix 2. The results clearly show that a low lignin hull has increased fibre digestibility and thus energy as compared to regular oat hulls. From animal response and nutrient behavior and assuming a 27 to 28% dry matter of oat grain being hulls, a 6.5 to 7.5 unit increase in total digestible nutrients can be expected with a low lignin hull. These results agree with previous *in vitro* studies showing increases in organic matter digestibility from 32% for regular oat hulls to 58 to 60% for a low lignin oat hull. The digestible NDF of the low lignin oat hulls will provide a unique addition to ruminant diets, particular to that of higher performance animals.

A dairy feeding trial comparing varieties of oat and barley is outlined in Appendix 3. This appendix describes the experimental protocol and contains a table summarizing the results. In this trial two cultivars of oats were compared to two cultivars of barley. Harrington barley is a widely grown malting type while Valier is characterized by containing starch which is more slowly fermented in the rumen. AC Assiniboia oats are the low lignin hull type and Derby are a normal type. Statistical analysis of the dairy production trial is not complete, but the difference of 2.8 kg between AC Assiniboia and Derby is expected to be significant. On a 3.5% fat corrected milk yield basis, AC Assiniboia appears to be equal to the two barley varieties.

To evaluate the overall competitiveness of an LLH-HOG oat grain could have from initial production through to marketing, a procedure developed with the Crops-Livestock Interface project was used. Shawn Senko, an Animal Science student, assisted with this portion and used the LLH-HOG oat as one of the test feed ingredients.

To establish production sustainability, cost of production scenarios of oat in different soil zones were compared to other grains. It was assumed that the tonnage yield of oats and barley were identical, although most knowledgeable estimates would place oats slightly greater in tonnage yield. Appendix 4 indicates that oat, in the black soil zone on conventional tilled stubble, has a much lower breakeven cost per tonne than barley ($113.82 vs. $122.74). This being the case, if the LLH-HOG oat has greater nutrient density than barley, its competitiveness in production and sustainability is very high.

The steer digestibility trials with low lignin hulls predicted a regular oat with a low lignin hull having 84.5% TDN on a dry matter basis. Barley in comparison has 82 to 83% TDN. In other modeling by D.A. Christensen, Appendix 5 shows the effect of a low lignin hull with increasing fat levels in the groat. Excessively high fat levels are undesirable as it interferes with fibre use. A fat level of 8% dry matter would appear to be most suitable as given by Appendix 5. This

predicts a TDN content of 87.5% on a dry matter basis as compared to that of 88% to 89% for corn. However, it is expected that the behavior of the fermentable fibre and protein quality of a LLH-HOG oat will place greater value on the oat than corn.

Several linear programming models were run to look at the competitiveness of the LLH-HOG oat grain in a beef grower diet in Western Canada and a high production dairy diet in Western Canada and Korea. The following table summarizes the data from Appendix 6.

Diet	Value $/tonne LL-HO oat	Corn grain
Dairy - Western Canada	$129.80	$116.60
Dairy - Korea	128.42	116.24
Beef (grower)	171.05	100.53

Summary

The dairy production trials and steer digestibilities clearly show increased energy content with a LLH oat. Further, it shows a unique role in diets from its fibre content not readily available from other feed sources. This provides not just a unique role, but increased value over its competitors, barley, and corn. Production economics shows good competitiveness and sustainability of production in Western Canada. The further development of this oat grain variety based on demonstrated potential should be of high priority.

Personnel - to 30/11/01

J. L. Ouellet - Casual labour CDC
L. M. Williams - Casual labour PFRC
A. K. Singh - Research Assistant CDC
M. I. Fehr - Technician PFRC
N .J. Webb - Technician PFRC
A. A. Koustov - Summer Student assistant
C. Sebulsky – Summer Student assistant
B. Diejomaoh – Casual Labour CDC

Equipment - none purchased

Project Developed Materials & Project photos - none

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